

1-26. (Cancelled)

27. (Previously Presented) An optical apparatus comprising:

a device for displaying an image; and

an ocular optical system for projecting an image formed by said device for displaying an image and for leading the image to an observer's eyeball;

said ocular optical system comprising first, second and third surfaces, in which a space defined by said first, second and third surfaces is filled with a medium having a refractive index larger than 1;

said first, second and third surfaces including, in order from an observer's eyeball side toward said device for displaying an image, a first surface serving as both a refracting surface and an internally reflecting surface, a second surface serving as a reflecting surface of positive power which faces said first surface and is decentered or tilted with respect to an observer's visual axis, and a third surface serving as a refracting surface closest to said device for displaying an image, at least two of said at least three surfaces having a finite curvature radius;

wherein any one of said first, second and third surfaces is a decentered aspherical surface;

wherein any one of said first, second and third surfaces is an anamorphic surface;

wherein said optical apparatus satisfies the following condition in a case where a vertical plane containing said observer's visual axis is defined as a YZ-plane, and a horizontal plane perpendicular to the YZ-plane is defined as an XZ-plane:

$$1 < |R_{y2}/R_{x2}| \leq 1.921$$

where  $R_{y2}$  is a curvature radius of said second surface in the YZ-plane, and  $R_{x2}$  is a curvature radius of said second surface in the XZ-plane.

28. (Previously Presented) An optical apparatus comprising:
- a device for displaying an image; and
  - an ocular optical system for projecting an image formed by said device for displaying an image and for leading the image to an observer's eyeball;
- said ocular optical system comprising first, second and third surfaces, in which a space defined by said at least first, second and third surfaces is filled with a medium having a refractive index larger than 1;
- said first, second and third surfaces including, in order from observer's eyeball side toward said device for displaying an image, a first surface serving as both a refracting surface and an internally reflecting surface, a second surface serving as a reflecting surface of positive power which faces said first surface and is decentered or tilted with respect to an observer's visual axis, and a third surface serving as a refracting surface closest to said device for displaying an image, at least two of said at least first, second and third surfaces having a finite curvature radius;
- wherein any one of said first, second and third surfaces is a decentered aspherical surface;
- wherein any one of said first, second and third surfaces is an anamorphic surface;
- wherein said optical apparatus satisfies the following condition in a case where a vertical plane containing said observer's visual axis is defined as a YZ-plane, and a horizontal plane perpendicular to the YZ-plane is defined as an XZ-plane:
- $$1 < |R_{y2}/R_{x2}| \leq 1.921$$
- where  $R_{y2}$  is a curvature radius of said second surface in the YZ-plane, and  $R_{x2}$  is a curvature radius of said second surface in the XZ-plane,
- wherein internal reflection that is performed by said first surface is total reflection.

29. (Previously Presented) An optical apparatus comprising:

a device for displaying an image; and

an ocular optical system for projecting an image formed by said device for displaying an image and for leading the image to an observer's eyeball,

said ocular optical system comprising first, second and third surfaces, in which a space defined by said at least first, second and third surfaces is filled with a medium having a refractive index larger than 1,

said first, second and third surfaces including, in order from an observer's eyeball side toward said device for displaying an image, a first surface serving as both a refracting surface and an internally reflecting surface, a second surface serving as a reflecting surface of positive power which faces said first surface and is decentered or tilted with respect to an observer's visual axis, and a third surface serving as a refracting surface closest to said device for displaying an image, at least two of said at least first, second and third surfaces having a finite curvature radius; and

wherein said first surface is a reflecting surface having a convex surface directed toward said second surface.

30. (Previously Presented) An optical apparatus comprising:

a device for displaying an image; and

an ocular optical system for projecting an image and for leading the image to an observer's eyeball,

said ocular optical system comprising first, second and third surfaces, in which a space defined by said at least first, second and third surfaces is filled with a medium having a refractive index larger than 1,

said first, second and third surfaces including, in order from an observer's eyeball side toward said device for displaying an image, a first surface serving as both a refracting surface and an internally reflecting surface, a second surface serving as a reflecting surface

of positive power which faces said first surface and is decentered or tilted with respect to an observer's visual axis, and a third surface serving as a refracting surface closest to said device for displaying an image, at least two of said at least first, second and third surfaces having a finite curvature radius;

wherein internal reflection that is performed by said first surface is total reflection, and

wherein said first surface is a reflecting surface having a convex surface directed toward said second surface.

31. (Previously Presented) An optical apparatus according to claim 29 or 30, wherein either one of said first and third surfaces of said ocular optical system is tilted or decentered with respect to said observer's visual axis.

32. (Previously Presented) An optical apparatus according to claim 31, further comprising means for positioning both said device for displaying an image and said ocular optical system with respect to an observer's head.

33. (Previously Presented) An optical apparatus according to claim 31, further comprising means for supporting both said device for displaying an image and said ocular optical system with respect to an observer's head so that said optical apparatus can be fitted to said observer's head.

34. (Previously Presented) An optical apparatus according to claim 31, further comprising means for supporting a pair of said optical apparatuses at a predetermined spacing.

35. (Previously Presented) An optical apparatus according to claim 31, wherein said ocular optical system is used as an imaging optical system.

36. (Previously Presented) An optical apparatus according to claim 31, which satisfies the following condition:

$$\theta = 27.5, 33.4, 26.4, 27.3, 28.2, \text{ or } 25.6,$$

where  $\theta$  is an angle between said visual axis and a line normal to said second surface of said ocular optical system in the vicinity of an intersection between said observer's visual axis and said second surface.

37. (Previously Presented) An optical apparatus according to claim 36, further comprising means for positioning both said device for displaying an image and said ocular optical system with respect to an observer's head.

38. (Previously Presented) An optical apparatus according to claim 36, further comprising means for supporting both said device for displaying an image and said ocular optical system with respect to an observer's head so that said optical apparatus can be fitted to said observer's head.

39. (Previously Presented) An optical apparatus according to claim 36, further comprising means for supporting a pair of said optical apparatuses at a predetermined spacing.

40. (Previously Presented) An optical apparatus according to claim 36, wherein said ocular optical system is used as an imaging optical system.

41. (Previously Presented) An optical apparatus according to claim 36, wherein said device for displaying an image has a display surface which is tilted with respect to said observer's visual axis.

42. (Previously Presented) An optical apparatus according to claim 41, further comprising means for positioning both said device for displaying an image and said ocular optical system with respect to an observer's head.

43. (Previously Presented) An optical apparatus according to claim 41, further comprising means for supporting both said device for displaying an image and said ocular optical system with respect to an observer's head so that said optical apparatus can be fitted to said observer's head.

44. (Previously Presented) An optical apparatus according to claim 41, further comprising means for supporting a pair of said optical apparatuses at a predetermined spacing.

45. (Previously Presented) An optical apparatus according to claim 41, wherein said ocular optical system is used as an imaging optical system.

46. (Previously Presented) An optical apparatus comprising:  
a device for displaying an image; and  
an ocular optical system for projecting an image formed by said device for displaying an image and for leading said image to an observer's eyeball,

said ocular optical system comprising at least first, second and third surfaces, in which a space defined by said surfaces is filled with a medium having refractive index larger than 1,

said device for displaying an image being disposed at a position facing said third surface,

said first, second and third surfaces including, in order from an observer's eyeball side toward said device for displaying an image, said first surface serving as both a refracting surface and an internally reflecting surface, said second surface serving as a reflecting surface of a positive power which faces said first surface and is decentered or tilted with respect to an observer's visual axis, and said third surface serving as a refracting surface closest to said device for displaying an image, at least two of said at least first, second and third surfaces having a finite curvature radius,

wherein any one of said first, second and third surfaces is a decentered aspherical surface,

wherein any one of said first, second and third surfaces is an anamorphic surface, and

said optical apparatus satisfies the following condition in a case where a vertical plane containing said observer's visual axis is defined as a YZ-plane, and a horizontal plane perpendicular to said YZ-plane is defined as an XZ-plane:

$$1 < |R_{y2}/R_{x2}| \leq 1.921$$

where  $R_{y2}$  is a curvature radius of said second surface in said YZ-plane, and  $R_{x2}$  is a curvature radius of said second surface in said XZ-plane.

47. (Previously Presented) An optical apparatus according to claim 46, further comprising means for positioning both said device for displaying an image and said ocular optical system with respect to an observer's head.

48. (Previously Presented) An optical apparatus according to claim 46, further comprising means for supporting both said device for displaying an image and said ocular optical system with respect to an observer's head so that said optical apparatus can be fitted to said observer's head.

49. (Previously Presented) An optical apparatus according to claim 46, further comprising means for supporting a pair of said optical apparatuses at a predetermined spacing.

50. (Previously Presented) An optical apparatus according to claim 46, wherein said ocular optical system is used as an imaging optical system.

51. (Previously Presented) An optical apparatus comprising:  
a device for displaying an image; and  
an ocular optical system for projecting an image formed by said device for displaying an image and for leading said image to an observer's eyeball,  
said ocular optical system comprising at least first, second and third surfaces, in which a space defined by said surfaces is filled with a medium having a refractive index larger than 1,  
said device for displaying an image being disposed at a position facing said third surface,  
said first, second and third surfaces including, in order from an observer's eyeball side toward said device for displaying an image, said first surface serving as both a refracting surface and an internally reflecting surface, said second surface serving as a reflecting surface of a positive power which faces said first surface and is decentered or tilted with respect to an observer's visual axis, and said third surface serving as a refracting



surface closest to said device for displaying an image, at least two of said at least first, second and third surface having a finite curvature radius,

wherein internal reflection that is performed by said first surface is total reflection, wherein any one of said first, second and third surfaces is a decentered aspherical surface,

wherein any one of said first, second and third surfaces is an anamorphic surface, and

said optical apparatus satisfies the following condition in a case where a vertical plane containing said observer's visual axis is defined as a YZ-plane, and a horizontal plane perpendicular to said YZ-plane is defined as an XZ-plane:

$$1 < |R_{y2}/R_{x2}| \leq 1.921$$

where  $R_{y2}$  is a curvature radius of said second surface in said YZ-plane, and  $R_{x2}$  is a curvature radius of said second surface in said XZ-plane.

52. (Previously Presented) An optical apparatus according to claim 51, further comprising means for positioning both said device for displaying an image and said ocular optical system with respect to an observer's head.

53. (Previously Presented) An optical apparatus according to claim 51, further comprising means for supporting both said device for displaying an image and said ocular optical system with respect to an observer's head so that said optical apparatus can be fitted to said observer's head.

54. (Previously Presented) An optical apparatus according to claim 51, further comprising means for supporting a pair of said optical apparatuses at a predetermined spacing.

55. (Previously Presented) An optical apparatus according to claim 51, wherein said ocular optical system is used as an imaging optical system.

56. (Previously Presented) An optical apparatus comprising:  
a device for displaying an image; and  
an ocular optical system for projecting an image formed by said device for displaying an image and for leading said image to an observer's eyeball,  
said ocular optical system comprising at least first, second and third surfaces, in which a space defined by said surfaces is filled with a medium having a refractive index larger than 1,

said device for displaying an image being disposed at a position facing said third surface,

said first second and third surfaces including, in order from an observer's eyeball side toward said device for displaying an image, said first surface serving as both a refracting surface and an internally reflecting surface, said second surface serving a reflecting surface of a positive power which faces said first surface and is decentered or tilted with respect to an observer's visual axis, and said third surface serving as a refracting surface closest to said device for displaying an image, at least two of said at least first, second and third surfaces having a finite curvature radius,

wherein said first surface is a reflecting surface having a convex surface directed toward said second surface.

57. (Previously Presented) An optical apparatus comprising:  
a device for displaying an image; and  
an ocular optical system for projecting an image formed by said device for displaying an image and for leading said image to an observer's eyeball,

said ocular optical system comprising at least first, second and third surfaces, in which a space defined by said surfaces is filled with a medium having a refractive index larger than 1,

said device for displaying an image being disposed at a position facing said third surface,

said first, second and third surfaces including, in order from an observer's eyeball side toward said device for displaying an image, said first surface serving as both a refracting surface and an internally reflecting surface, said second surface serving as a reflecting surface of a positive power which faces said first surface and is decentered or tilted with respect to an observer's visual axis, and said third surface serving as a refracting surface closest to said device for displaying an image, at least two of said at least first, second and third surfaces having a finite curvature radius,

wherein internal reflection that is performed by said first surface is total reflection, and

wherein said first surface is a reflecting surface having a convex surface directed toward said second surface.

58. (Previously Presented) An optical apparatus according to claim 56 or 57, further comprising means for positioning both said device for displaying an image and said ocular optical system with respect to an observer's head.

59. (Previously Presented) An optical apparatus according to claim 56 or 57, further comprising means for supporting both said device for displaying an image and said ocular optical system with respect to an observer's head so that said optical apparatus can be fitted to said observer's head.

60. (Previously Presented) An optical apparatus according to claim 56 or 57, further comprising means for supporting a pair of said optical apparatuses at a predetermined spacing.

61. (Previously Presented) An optical apparatus according to claim 56 or 57, wherein said ocular optical system is used as an imaging optical system.

62-70. (Cancelled)

71. (Previously Presented) An optical apparatus according to any of claims 27, 28, and 46 through 55, wherein the following condition is met:

$$1.421 \leq R_{y2}/R_{x2} \leq 1.921.$$

72. (Previously Presented) An optical apparatus according to claim 71, wherein the following condition is met:

$$R_{y2}/R_{x2}=1.421, 1.921, 1.730, 1.732, 1.493, 1.921, 1.802 \text{ or } 1.820.$$

73. (Previously Presented) An optical apparatus according to claim 72, wherein the following condition is met:

- (a)  $R_{y2}=-57.595$  and  $R_{x2}=-40.526$ ;
- (b)  $R_{y2}=-63.157$  and  $R_{x2}=-32.870$ ;
- (c)  $R_{y2}=-67.136$  and  $R_{x2}=-38.803$ ;
- (d)  $R_{y2}=-66.938$  and  $R_{x2}=-38.651$ ;
- (e)  $R_{y2}=-63.546$  and  $R_{x2}=-42.575$ ;
- (f)  $R_{y2}=-63.157$  and  $R_{x2}=-32.870$ ;
- (g)  $R_{y2}=-65.701$  and  $R_{x2}=-36.469$ ; or

(h)  $R_{y2} = -65.600$  and  $R_{x2} = -36.035$ .

74. (Previously Presented) An optical apparatus according to any of claims 27, 28, and 46 through 55, wherein the XZ-plane passes through the vertex of said second surface and is perpendicular to the tangent at the vertex.

75. (Previously Presented) An optical apparatus according to claim 71, wherein the XZ-plane passes through the vertex of said second surface and is perpendicular to the tangent at the vertex.

76. (Previously Presented) An optical apparatus according to claim 72, wherein the XZ-plane passes through the vertex of said second surface and is perpendicular to the tangent at the vertex.

77. (Previously Presented) An optical apparatus according to claim 73, wherein the XZ-plane passes through the vertex of said second surface and is perpendicular to the tangent at the vertex.

78. (Previously Presented) An optical apparatus according to Claim 27, wherein said medium is acrylic resin or glass.

79. (Previously Presented) An optical apparatus according to Claim 28, wherein said medium is acrylic resin or glass.

80. (Previously Presented) An optical apparatus according to Claim 29, wherein said medium is acrylic resin or glass.

81. (Previously Presented) An optical apparatus according to Claim 30, wherein said medium is acrylic resin or glass.

82. (Previously Presented) An optical apparatus according to Claim 31, wherein said medium is acrylic resin or glass.

83. (Previously Presented) An optical apparatus according to Claim 32, wherein said medium is acrylic resin or glass.

84. (Previously Presented) An optical apparatus according to Claim 33, wherein said medium is acrylic resin or glass.

85. (Previously Presented) An optical apparatus according to Claim 34, wherein said medium is acrylic resin or glass.

86. (Previously Presented) An optical apparatus according to Claim 35, wherein said medium is acrylic resin or glass.

87. (Previously Presented) An optical apparatus according to Claim 36, wherein said medium is acrylic resin or glass.

88. (Previously Presented) An optical apparatus according to Claim 37, wherein said medium is acrylic resin or glass.

89. (Previously Presented) An optical apparatus according to Claim 38, wherein said medium is acrylic resin or glass.

90. (Previously Presented) An optical apparatus according to Claim 39, wherein said medium is acrylic resin or glass.

91. (Previously Presented) An optical apparatus according to Claim 40, wherein said medium is acrylic resin or glass.

92. (Previously Presented) An optical apparatus according to Claim 41, wherein said medium is acrylic resin or glass.

93. (Previously Presented) An optical apparatus according to Claim 42, wherein said medium is acrylic resin or glass.

94. (Previously Presented) An optical apparatus according to Claim 43, wherein said medium is acrylic resin or glass.

95. (Previously Presented) An optical apparatus according to Claim 44, wherein said medium is acrylic resin or glass.

96. (Previously Presented) An optical apparatus according to Claim 45, wherein said medium is acrylic resin or glass.

97. (Previously Presented) An optical apparatus according to Claim 46, wherein said medium is acrylic resin or glass.

98. (Previously Presented) An optical apparatus according to Claim 47, wherein said medium is acrylic resin or glass.

99. (Previously Presented) An optical apparatus according to Claim 48, wherein said medium is acrylic resin or glass.

100. (Previously Presented) An optical apparatus according to Claim 49, wherein said medium is acrylic resin or glass.

101. (Previously Presented) An optical apparatus according to Claim 50, wherein said medium is acrylic resin or glass.

102. (Previously Presented) An optical apparatus according to Claim 51, wherein said medium is acrylic resin or glass.

103. (Previously Presented) An optical apparatus according to Claim 52, wherein said medium is acrylic resin or glass.

104. (Previously Presented) An optical apparatus according to Claim 53, wherein said medium is acrylic resin or glass.

105. (Previously Presented) An optical apparatus according to Claim 54, wherein said medium is acrylic resin or glass.

106. (Previously Presented) An optical apparatus according to Claim 55, wherein said medium is acrylic resin or glass.

107. (Previously Presented) An optical apparatus according to Claim 56, wherein said medium is acrylic resin or glass.



108. (Previously Presented) An optical apparatus according to Claim 57, wherein said medium is acrylic resin or glass.

109. (Previously Presented) An optical apparatus according to Claim 58, wherein said medium is acrylic resin or glass.

110. (Previously Presented) An optical apparatus according to Claim 59, wherein said medium is acrylic resin or glass.

111. (Previously Presented) An optical apparatus according to Claim 60, wherein said medium is acrylic resin or glass.

112. (Previously Presented) An optical apparatus according to Claim 61, wherein said medium is acrylic resin or glass.

113. (Previously Presented) An optical apparatus according to Claim 71, wherein said medium is acrylic resin or glass.

114. (Previously Presented) An optical apparatus according to Claim 72, wherein said medium is acrylic resin or glass.

115. (Previously Presented) An optical apparatus according to Claim 73, wherein said medium is acrylic resin or glass.

116. (Previously Presented) An optical apparatus according to Claim 74, wherein said medium is acrylic resin or glass.

117. (Previously Presented) An optical apparatus according to Claim 75, wherein said medium is acrylic resin or glass.

118. (Previously Presented) An optical apparatus according to Claim 76, wherein said medium is acrylic resin or glass.

119. (Previously Presented) An optical apparatus according to Claim 77, wherein said medium is acrylic resin or glass.

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